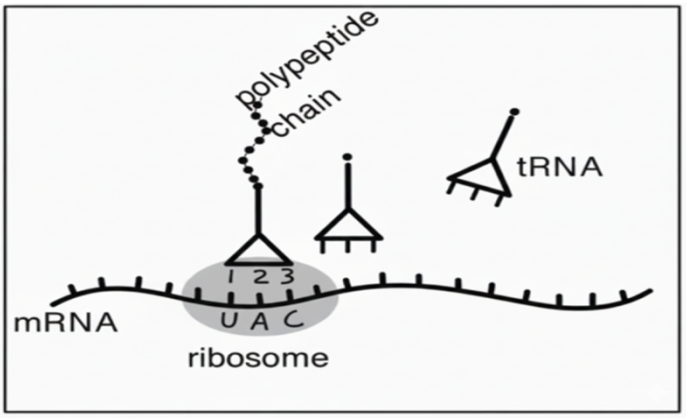
Chapter 4 molecular genetics

The figure below represents an important process that occurs in the human cell. Refer to the figure to answer the questions that follow.



1) What process does this figure represent?

a) DNA replication
b) RNA processing
c) Protein synthesis
d) Transcription
e) None of the above.

2) The numbers 123 on the tRNA must be replaced with the following anti-codon:

a) UAC
b) CAU
c) AUG
d) UAG
e) AUC

Questions 3–5

A. Transcription
B. Translation
C. DNA replication
D. RNA processing

3) This process takes place in the cytoplasm.

4) This process takes place during the S phase of the cell cycle.

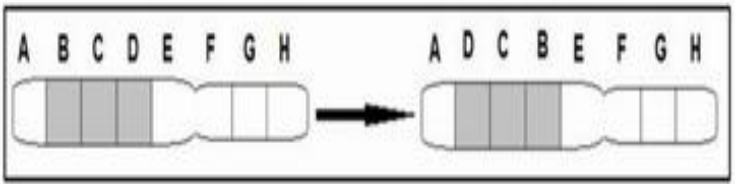
5) The mRNA is ready to exit the nucleus.

6) An experiment was conducted on mice to test the effect of different levels of radiation on the formation of protein X. After many trials, scientists noticed that the amino acid sequence in protein X formed by these mice was different by one amino acid compared to the original one. The mutation that has occurred in these mice is:

I. nonsense mutation
II. silent mutation
III. missense mutation

a) I only
b) II only
c) III only
d) I and II only
e) None of the above.

7) What type of chromosomal mutation is represented in the figure below?



a) deletion
b) addition
c) translocation
d) silent mutation
e) inversion

8) Suppose you are provided with an actively dividing culture of Streptococcus aureus bacteria to which radioactive thymine has been added. What would happen if a cell replicates once in the presence of this radioactive base?

a) One of the daughter cells, but not the other, would have radioactive DNA.
b) Neither of the two daughter cells would be radioactive.
c) All four bases of the DNA would be radioactive.
d) Radioactive thymine would pair with nonradioactive guanine.
e) DNA in both daughter cells would be radioactive.

9) Human chromosome 1 constitutes 270 × 10^6 base pairs (bp). It undergoes the action of a restriction enzyme which has a restriction site every 3000 bases. The number of restriction fragments is

a) 270000
b) 90000
c) 90001
d) 89999
e) 270001

10) What is a section of DNA that codes for a protein called?

a) gene
b) allele
c) chromosome
d) plasmid
e) transcription

11) A man with Klinefelter's syndrome has 47 chromosomes and has three sex chromosomes, XXY. This abnormality came about as a result of

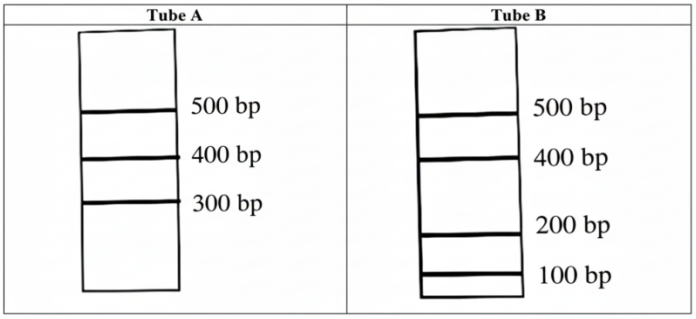
a) crossing-over.
b) a deletion of a chromosome.
c) an addition of a chromosome.
d) nondisjunction.
e) a mutation in a gene.

12) If guanine makes up 28% of the nucleotides in a sample of DNA from an organism, then thymine would make up ____ % of the nucleotides.

a) 0
b) 22
c) 28
d) 44
e) 56

Questions 13–14

The genes coding for one of the MHC proteins, DQ, are extracted from two identical skin cells and put in two tubes A and B. The same restriction enzyme is added to the two tubes. The produced fragments from each tube are separated by gel electrophoresis. The results are tabulated below.



13) The length in base pair (bp) of this gene is

a) 1000 bp
b) 2400 bp
c) 1200 bp
d) 1100 bp
e) 900 bp

14) The result indicates that a mutation at the level of the DQ gene has taken place at fragment

a) 400
b) 500
c) 300
d) 200
e) 90

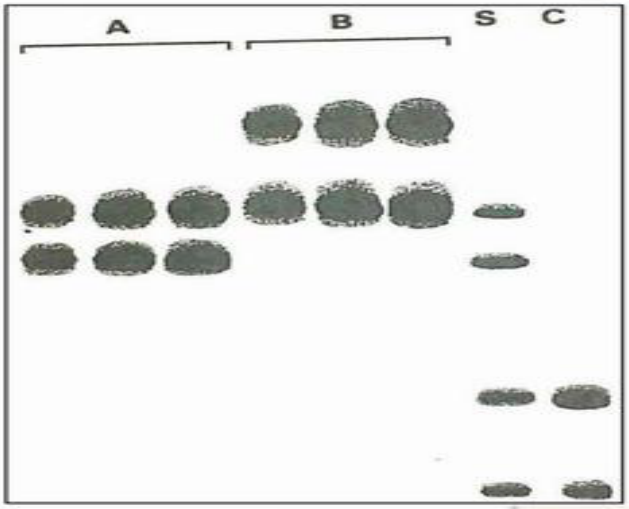
15) Mutations are a permanent alteration that attack sequences of genes. The following strand is a strand of DNA coding for estrogen, a sexual hormone.

3'ACC.GAC.TAT.ATA.TAT.CCG.CAC.TAC.TTC .GAC.ACT 5'

A mutation by deletion attacks the ninth nucleotide. The mutated sequence will be

a)3`ACC.GAC.TAC.ATA.TAT.CCG.CAC.TAC.T TC.GAC.ACT 5'
b)3`ACC.GAC.TAG.TAT.ATC.CGC.ACT.ACT.T CG.ACA.CT 5'
c)3`ACC.GAC.TAT.ATA.TAT.CCG.CAC.TAC.G AC.ACT 5'
d)3`ACC.GAC.TAA.TAT.ATC.CGC.ACT.ACT.T CG.ACA.CT 5'
e)5`ACC.GAC.TAG.ATA.TAT.CCG.CAC.TAC. GAC.ACT 3'

6) Three individuals A, B, and C are suspects in a murder case. Based on blood stains collected from victim S, we obtained, with a specific probe of a determined locus, the DNA fingerprint S. The DNA fingerprint of suspect A was obtained with the same probe based on blood, skin, and hair samples; the same goes for the fingerprint of B. The DNA fingerprint of C was obtained based on a blood sample.



Based on the results, we can conclude that
a) suspects B and C participated in the murder.
b) suspects A and C participated in the murder.
c) suspects A and B participated in the murder.
d) the three suspects A, B, and C participated in the murder.
e) none of the suspects participated in the murder.

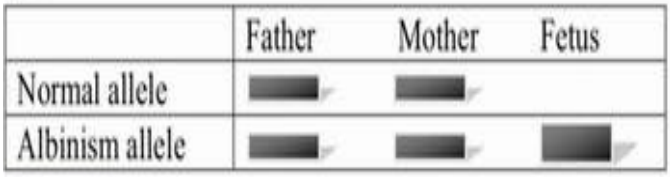
17) In gel electrophoresis, DNA bands are separated according to

a) Their solubility in agarose gel
b) The sequence of nucleotides
c) Composition of nitrogenous bases
d) Size of fragment
e) Size of fragment and sequence of nucleotides

18) A piece of DNA is amplified by

a) Gel electrophoresis
b) DNA recombination
c) PCR
d) Addition of restriction enzymes
e) Transcription

19) A couple with normal phenotype, who each have a family history of albinism, is expecting a baby. They had DNA fingerprinting in order to determine their genotypes and to know if the fetus is going to be albino or not. The following document shows the fingerprinting for this couple and their fetus.



From the above DNA fingerprinting, we can conclude that

a) The allele for albinism is dominant and the fetus will have the condition

b) The allele for albinism is dominant and the fetus will not have the condition

c) The allele for albinism is recessive and the fetus will have the condition

d) The allele for albinism is recessive and the fetus will not have the condition

e) The allele for albinism is recessive and masks the normal allele

20) RNA processing involves

a) Removal of introns
b) Formation of m-RNA
c) Formation of peptide
d) Formation of DNA
e) Removal of exons

21) 35% of the nitrogenous bases that form a DNA segment is Guanine, then the percentages of Thymine is

a) 15 %
b) 35%
c) 30%
d) 70%
e) 50%

22) Which of the following m-RNA strands is complementary to the given transcribed DNA strand?
CCGATAGATCAAA transcribed DNA strand

a) CCGAUAGAUCAAA
b) GGCUAUCUAGUUU
c) GGCTATCTAGTTT
d) GGCUAUCUAGUU
e) GGCUAAGAAGUUU

23) A biology class was performing an experiment in the lab. The students had obtained a DNA strand with radioactive thymine. Later as they left the strand in a medium for multiplication, they realized that the radioactivity was observed only in part of the DNA and not all DNA molecules.

The process was explained by the teacher as:
a) DNA translation
b) Cell proliferation
c) Semi-conservative replication of DNA
d) Conservative replication of DNA
e) Semi-conservative translation of DNA

24) A DNA nucleotide consists of:

a) Phosphate group, deoxyribose sugar and nitrogenous base (A, C, G or T)
b) Phosphate group, ribose sugar and nitrogenous base (A, C, G or T)
c) Phosphate group, deoxyribose sugar and nitrogenous base (A, T, G or U)
d) Phosphate group, deoxyribose sugar and nitrogenous base (A, C, G or T)
e) Phosphate group, deoxyribose sugar and nitrogenous base (T, C, G or U)

25) The best definition of a gene is that it is:

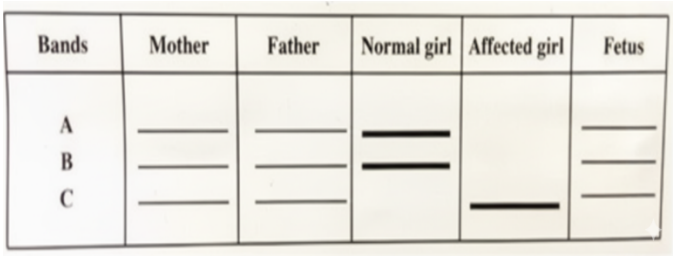
a) A sequence of amino acids which makes up a polypeptide
b) A sequence of ribonucleotides which makes up a DNA and codes for polypeptide
c) A sequence of deoxyribonucleotides which makes up the DNA and is transcribed to RNA then translated to a polypeptide
d) Any sequence of deoxyribonucleotides which makes up the DNA
e) Any sequence of ribonucleotides which makes up a DNA

26) A DNA molecule has 20% A and 30% G. The total number of nucleotides in the DNA molecule is 20. The number of thymine nitrogenous bases in the DNA is:

a) 2
b) 3
c) 4
d) 5
e) 6

Questions 27–29:

Tay-Sachs disease is known as an infantile disease which is characterized by relentless deterioration of mental and physical abilities. It begins at 6 months of age and usually results in death by the age of five. A couple has two girls out of which one is 2 years old and has the disease. The mother got pregnant and she is afraid of having another affected child. She visited a genetic counselor who requested that a DNA analysis test be completed for the whole family. The results of the DNA analysis of all family members are shown in the following table.



27) Based on the above given, the band(s) which correspond(s) to the:

a) Disease are bands A and C
b) Disease are bands B and C
c) Normal phenotype is band A
d) Normal phenotype are bands A and B
e) Normal phenotype are bands A and C

28) Depending on the test analysis, the fetus is:
a) Of unknown genotype
b) Normal carrier of the disease
c) Normal with homozygous genotype
d) Diseased with homozygous genotype
e) Diseased with heterozygous genotype

29) The locus of the gene coding for the disease is on:
a) An autosome
b) X chromosome segment not homologous with Y
c) Y chromosome segment not homologous with X
d) Homologous segment of X and Y sex chromosomes
e) Can't be determined with this data

30) The document below represents the normal and the mutant DNA sequence coding for a protein.

Normal DNA sequence: TAT CAT CCT AAG GTA
Mutant DNA sequence: TAT CAT CGT AAG GTA

The mutation that affects the DNA sequence is:
a) Mutation by substitution
b) Mutation by deletion
c) Mutation by addition
d) Silent mutation due to deletion mutation
e) Mutation by insertion

Questions 31–34: Each set of lettered choices below refers to the numbered questions or statements immediately following it. Select the one lettered choice that best answers each question and fill in the corresponding space on the answer sheet. A choice may be used once, more than once, or not at all in each set.

A. DNA polymerase
B. RNA polymerase
C. helicase
D. ligase
E. restriction enzyme

31) is responsible for unwinding the strands of DNA during replication

32) plays a major role during transcription

33) a protein that cleaves DNA at specific sites

34) is responsible for linking the two sections of DNA during replication

35) What type of mutation is shown in the amino acid sequence of the mutated DNA compared to the normal sequence of amino acids in the table below?

normal DNA:	TAC TTG AAT CGT
normal mRNA:	AUG AAC UUA GCA
normal amino acid:	met – asn – leu – ala

mutated DNA:	TAC TTG ATT CGT
mRNA:	?
amino acid:	?

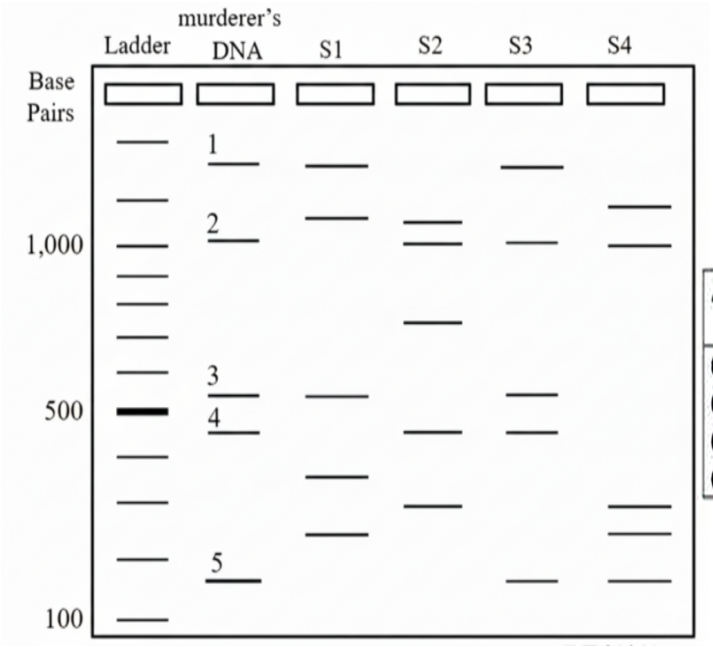
Second letter

First letter	U	C	A	G	Third letter
U	UUU, UUC: Phe UUA, UUG: Leu	UCU, UCC, UCA, UCG: Ser	UAU, UAC: Tyr **UAA Stop** **UAG Stop**	UGU, UGC: Cys **UGA Stop** UGG Trp	U C A G
C	CUU, CUC, CUA, CUG: Leu	CCU, CCC, CCA, CCG: Pro	CAU, CAC: His CAA, CAG: Gln	CGU, CGC, CGA, CGG: Arg	U C A G
A	AUU, AUC, AUA: Ile **AUG Met**	ACU, ACC, ACA, ACG: Thr	AAU, AAC: Asn AAA, AAG: Lys	AGU, AGC: Ser AGA, AGG: Arg	U C A G
G	GUU, GUC, GUA, GUG: Val	GCU, GCC, GCA, GCG: Ala	GAU, GAC: Asp GAA, GAG: Glu	GGU, GGC, GGA, GGG: Gly	U C A G

a) silent mutation
b) missense mutation
c) nonsense mutation
d) deletion
e) insertion

Questions 36–37: Refer to the given below

DNA fingerprinting uses gel electrophoresis technology to show the genetic make-up of a living organism; it is mostly used in solving crimes or paternity cases. The figure below shows gel electrophoresis representing DNA samples from four suspects of a murder case (S1–S4), along with DNA found from hair sample that belongs to the murderer.



36) Which one of these numbers represents the largest DNA fragment?
a) 1
b) 2
c) 3
d) 4
e) 5

37) Which one of these suspects is most likely to be the murderer?
a) suspect 1
b) suspect 2
c) suspect 3
d) suspect 4
e) more tests are needed

Questions 38–40

A. nucleic acid
B. ribosomes
C. cell wall
D. plasma membrane
E. mitochondria

38) this can only be found in eukaryotic cells

39) this is absent from animal cells

40) can bind to tRNA

41) A whole gene codes for the following tetrapeptide:

Arginine – Lysine – Proline – Valine

Given the following table:

Arg	Lys	Met	Pro	Gly	Val	His	Stop codon
CGU	AAA	AUG	CCC	GGU	GUU	CAU	UGA
CGC	AAG		CCU	GGC	GUC	CAC	UAA
CGA			CCA	GGA	GUA		UAG
CGG			CCG	GGG	GUG		

The possible sequence of nucleotides on the transcribed strand of the gene is:
a) GGTAAACCTGTTTAA
b) AUGCGUAAACCCGUUUAA
c) TACGCATTTGGACAAATT
d) CGUAAACCCGUU
e) TACCGTAAACCTGTTTAAATT

42) Klinefelter syndrome is a genetic disorder that affects males. Turner syndrome is a genetic disorder that affects females. The following table shows these two diseases.

What is the main cause of these two diseases?
a) Changes in the genomic sequence
b) Mutation
c) Abnormal distribution of chromosomes
d) Bacterial infection
e) Changes in the genomic sequence and abnormal distribution of chromosomes

43) An echography done to a pregnant woman shows that the fetus has phenotypic abnormalities. The amniocentesis test done on embryonic cells obtained from the amniotic sac shows the following karyotype.

The cause of this abnormality is that the zygote results from the union of sperm and oocyte II where the:
a) Oocyte has (n+1) chromosomes
b) Sperm has (n+1) chromosomes
c) Sperm has n chromosomes
d) Oocyte has n chromosomes
e) Sperm or oocyte has 2n chromosomes

Questions **44 – 45**:

Restriction enzymes cut the DNA molecules at specific sites called restriction sites within a sequence of nucleotides which is called the recognition sequence. For example:

Restriction enzyme	Recognition sequence	Cleavage site
Hae III	5'---GGCC---3' 3'---CCGG---5'	5'--GG CC--3' 3'--CC GG--5'
Eco RI	5'---GAATTC---3' 3'---CTTAAG---5'	5'--G AATT--3' 3'--CTTAA G-5'
Bam HI	5'---GGATCC---3' 3'---CCTAGG---5'	5'--G GATCC-3' 3'--CCTAG G-5'

44) One property of the recognition sequence of restriction enzymes is that they are **palindromic**.
The meaning of palindromic is that the recognition sequence reads the same on both DNA strands from:

a) 5' to 3' on one strand and 3' to 5' on the opposite strand
b) 3' to 5' on one strand and 5' to 3' on the opposite strand
c) 5' to 3' direction only on one strand
d) 3' to 5' direction only on one strand
e) 5' to 3' direction on both strands or 3' to 5' on both strands

45) Based on question **31**, you can infer that a specific enzyme has the following **recognition sequence**:
a) 5'—TAGC—3'
3'—ATCG—5'

b) 5'—TCGA—3'
3'—AGCT—5'

c) 5'—TCCA—3'
3'—AGGT—5'

d) 5'—ACGA—3'
3'—TGCT—5'

e) 5'—TATC—3'
3'—ATAG—5'

Questions **46–47**:

The following table represents the percentage of nitrogenous bases present in the whole DNA molecules extracted from two differentiated body cells of a horse A and a horse B.

% of nitrogenous bases in DNA	A	T	C	G
Thyroid cell of horse A	28.2	28.3	21.4	21.6
Skin cell of horse A	28.2	28.3	21.4	21.6
Thyroid cell of horse B	26.5	26.5	23.5	23.5
Skin cell of horse B	26.5	26.5	23.5	23.5

46) By comparing the % of nitrogenous bases present in the thyroid cell of horse A to that in the thyroid cell of horse B, one can infer that:

a) All somatic cells of the same species have the same % of nitrogenous bases.
b) Cells of different animals of the same species have different % of nitrogenous bases.
c) In somatic cells, only the % of adenine is equal to % of thymine, and the % of guanine is equal to the % of cytosine.
d) In any cell, the % of adenine is equal to the % of guanine and the % of thymine is equal to the % of cytosine.
e) In gamete cell, only the % of adenine is equal to % of thymine, and the % of guanine is equal to the % of cytosine.

47) By comparing the % of nitrogenous bases present in the thyroid cell of horse A with the % of nitrogenous bases present in the skin cell of horse A, one can infer that:

a) All somatic cells of the same animal have the same % of nitrogenous bases.
b) Cells of different animals of the same species have different % of nitrogenous bases.
c) All somatic cells of the same species have the same % of nitrogenous bases.
d) In any cell, the % of adenine is equal to the % of guanine and the % of thymine is equal to the % of cytosine.
e) In any cell, the % of adenine is equal to the % of cytosine
and the % of thymine is equal to the % of guanine.

48) The following table includes incorrect information
about DNA and RNA.

DNA	RNA
It is found in the nucleus	It is found in the nucleus and in the cytoplasm
Its sugar is ribose	Its sugar is deoxyribose
It is typically a double-stranded molecule with a long chain of nucleotides	It is a single-stranded molecule in most of its biological role and has a shorter chain of nucleotides
Its bases are A, U, C, G	Its bases are A, T, C, G
It is a medium of long-term storage and transmission of genetic information	Its main job is to transfer the genetic code needed for the synthesis of proteins from the nucleus to the ribosome

Consider the following statements to answer the question that follows:

I. Sugar of DNA is deoxyribose and that of RNA is ribose.
II. DNA can also be present in the cytoplasm.
III. Bases of DNA are A, T, C, G and those of RNA are A, U, C, G.
IV. DNA can sometimes play a role of RNA and transfer the genetic code from the nucleus to the ribosome.

Which statement(s) correct(s) the table above?

a) I
b) III
c) I and III
d) I and II
e) II and IV

Questions 49–52:

Three identical DNA molecules, made up of 40 nucleotides
each, all have their thymine nucleotides radioactive on both strands.They are cultured independently in 3 test tubes containing different contents and placed in a water bath at 37°C for adesignated time to undergo DNA replication 3 times.In these tubes, the added nucleotides contain non-radioactive nitrogenous bases.

Contents of Tubes:

Tube	Nucleotides	Energy Molecules	DNA Polymerase
1	+	+	+
2	+	+	-
3	+	-	+

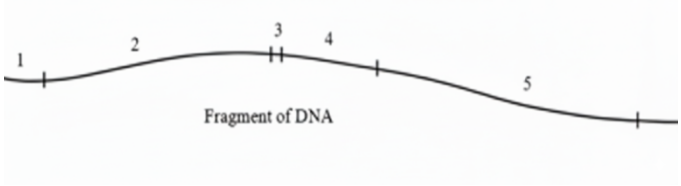
47) In which of the above tube(s), will DNA replication take place?
a) In tube 1
b) In tube 2
c) In tube 3
d) In tubes 1 and 3
e) In tubes 1, 2, and 3

48) At the end of the experiment the number of DNA molecules in the tube(s) that undergo(es) DNA replication will be:
a) 1
b) 2
c) 4
d) 6
e) 8

49) The % of DNA molecules which are radioactive at the end of the experiment will be:
a) 6.25%
b) 12.5%
c) 25%
d) 32%
e) 50%

50) A cell containing 46 chromosomes with 2 chromatids each. Each cell contains:
a) 46 DNA molecules
b) 23 DNA molecules
c) 92 DNA molecules
d) 184 DNA molecules
e) 48 DNA molecules

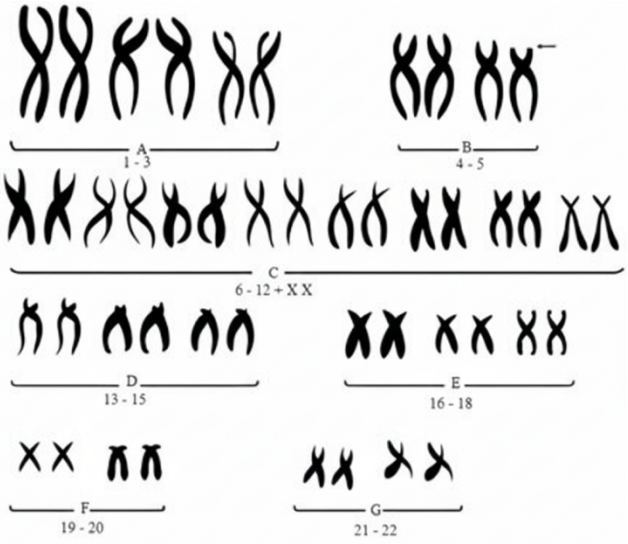
51) Fragment of DNA cut at certain points and run through a gel:



At the end of the experiment, which choice represents the correct order of DNA fragments, starting from the wells toward the positive end?

a) 1, 2, 3, 4, 5
b) 5, 4, 3, 2, 1
c) 5, 2, 4, 1, 3
d) 5, 2, 3, 1, 4
e) 3, 1, 4, 2, 5

52) The karyotype of an infant having "cri du chat syndrome" presents an abnormality in one of the two chromosomes 5.



This abnormality is called:

a) Inversion
b) Translocation
c) Deletion
d) Trisomy
e) Substitution